Unit -2

- What is an **Ecosystem**?

✓ An ecosystem is a community of living organisms in conjunction with the non-living components of their environment, interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.

✓ The simplest definition of an ecosystem is that it is a community or group of living organisms that live in and interact with each other in a specific environment.

✓ **For instance**, tropical forests are ecosystems made up of living beings such as trees, plants, animals, insects and micro-organisms that are in constant interaction between themselves and that are affected by other physical (sun, temperature) or chemical (oxygen or nutrients) components.

✓ An ecosystem can be categorized into its abiotic constituents, including minerals, climate, soil, water, sunlight, and all other nonliving elements, and its biotic constituents, consisting of all its living members. Linking these constituents together are two major forces: the flow of energy through the ecosystem, and the cycling of nutrients within the ecosystem.

✓ Every factor in an ecosystem depends on every other factor, either directly or indirectly. A change in the temperature of an ecosystem will often affect what plants will grow there, for instance. Animals that depend on plants for food and shelter will have to adapt to the changes, move to another ecosystem, or perish.

✓ Ecosystems can be very large or very small. Tide pools, the ponds left by the ocean as the tide goes out, are complete, tiny ecosystems. Tide pools contain seaweed, a kind of algae, which uses photosynthesis to create food. Herbivores such as abalone eat the seaweed. Carnivores such as sea stars eat other animals in the tide pool, such as clams or mussels.

✓ Tide pools depend on the changing level of ocean water. Some organisms, such as seaweed, thrive in an aquatic environment, when the tide is in and the pool is full. Other organisms, such as hermit crabs, cannot live underwater and depend on the shallow pools left by low tides. In this way, the biotic parts of the ecosystem depend on abiotic factors.

✓ The whole surface of Earth is a series of connected ecosystems. Ecosystems are often connected in a larger biome. Biomes are large sections of land, sea, or atmosphere. Forests, ponds, reefs, and tundra are all types of biomes, for example. They're organized very generally, based on the types of plants and animals that live in them. Within each forest, each pond, each reef, or each section of tundra, you'll find many different ecosystems.

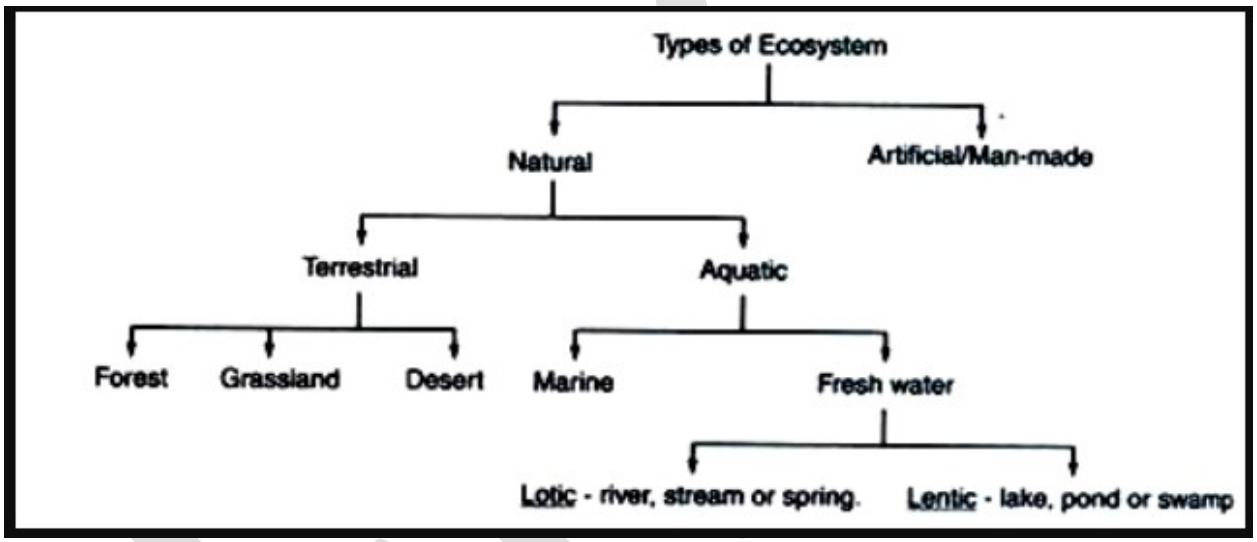
✓ The biome of the Sahara Desert, for instance, includes a wide variety of ecosystems. The arid climate and hot weather characterize the biome. Within the Sahara are oasis ecosystems, which have date palm trees, freshwater, and animals such as crocodiles.

✓ The Sahara also has dune ecosystems, with the changing landscape determined by the wind. Organisms in these ecosystems, such as snakes or scorpions, must be able to survive in sand dunes for long periods of time.

- ✓ The Sahara even includes a marine environment, where the Atlantic Ocean creates cool fogs on the Northwest African coast. Shrubs and animals that feed on small trees, such as goats, live in this Sahara ecosystem.
- ✓ Even the cold desert ecosystems of the Gobi are distinct from the freezing desert ecosystems of Antarctica. Antarctica's thick ice sheet covers a continent made almost entirely of dry, bare rock. Only a few mosses grow in this desert ecosystem, supporting only a few birds, such as skuas.
- ✓ The largest ecosystem in the world is the aquatic ecosystem. It comprises freshwater and marine ecosystem. It constitutes 70% of the surface of the earth.

- **<u>Types of Ecosystem:</u>**

  We can classify ecosystems as follows:



Natural ecosystems	Artificial ecosystems
A biological environment occurring freely in nature rather than being created by man is called as a natural ecosystem	Ecosystems that are made by man for commercial or other benefits is known as an artificial ecosystem. These ecosystems are modified by humans for their own profit and can either be terrestrial or aquatic
Example: Desert, forest	**Example**: Aquariums, crop fields, dams, gardens

- ✓ An ecosystem can be as small as an oasis in a desert, or as big as an ocean, spanning thousands of miles. There are **two** types of ecosystem:

- Terrestrial Ecosystem
- Aquatic Ecosystem

Terrestrial Ecosystems Terrestrial ecosystems are exclusively land-based ecosystems. There are different types of terrestrial ecosystems distributed around various geological zones. They are as follows:

1. Forest Ecosystems
2. Grassland Ecosystems
3. Tundra Ecosystems
4. Desert Ecosystem

Forest Ecosystem: A forest ecosystem consists of several plants, animals and microorganisms that live in coordination with the abiotic factors of the environment. Forests help in maintaining the temperature of the earth and are the major carbon sink.

Grassland Ecosystem: In a grassland ecosystem, the vegetation is dominated by grasses and herbs. Temperate grasslands, savanna grasslands are some of the examples of grassland ecosystems.

Tundra Ecosystem: Tundra ecosystems are devoid of trees and are found in cold climates or where rainfall is scarce. These are covered with snow for most of the year. The ecosystem in the Arctic or mountain tops is tundra type.

Desert Ecosystem: Deserts are found throughout the world. These are regions with very little rainfall. The days are hot and the nights are cold.

Aquatic Ecosystem: Aquatic ecosystems are ecosystems present in a body of water. These can be further divided into two types, namely:

1. Freshwater Ecosystem
2. Marine Ecosystem

Freshwater Ecosystem

The freshwater ecosystem is an aquatic ecosystem that includes lakes, ponds, rivers, streams and wetlands. These have no salt content in contrast with the marine ecosystem.

Marine Ecosystem

The marine ecosystem includes seas and oceans. These have a more substantial salt content and greater biodiversity in comparison to the freshwater ecosystem.

- **Basic Structure of an Ecosystem:** Every ecosystem has a non-living (abiotic) and living (biotic) components.
- ✓ **Abiotic Components**: Basic inorganic compounds of an organism, habitat or an area like carbon dioxide, water, nitrogen, calcium, phosphorus, etc. that are involved in the material cycles are collectively called as abiotic component.
- ✓ The amount of these inorganic substances present at any given time, in an ecosystem is called as the standing state or standing quality of an ecosystem.

- ✓ Whereas, organic components e.g., proteins, amino acids, carbohydrates and lipids that are synthesized by the biotic counterpart of an ecosystem make the biochemical structure of the ecosystem. The physical environment, viz. climatic and weather conditions are also included in the abiotic structure of the ecosystem.

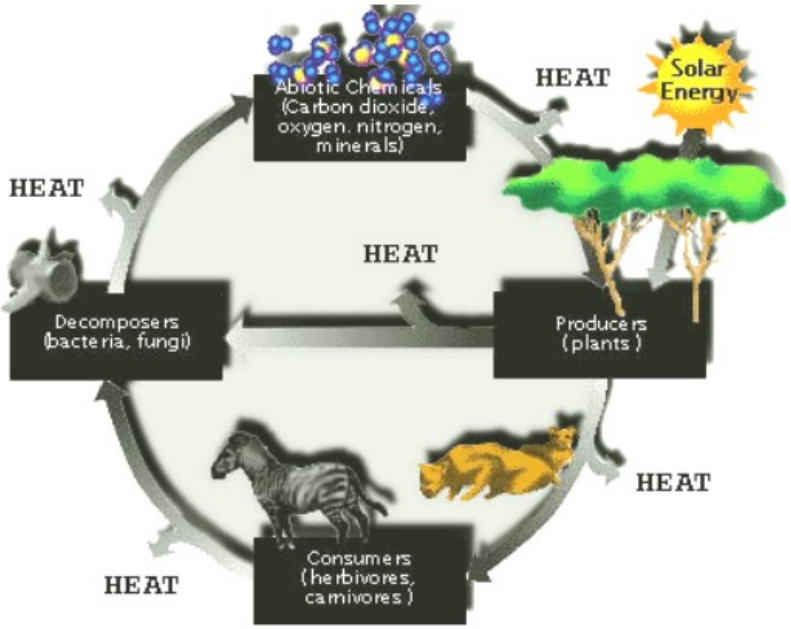
- ✓ **Biotic Components:** From the trophic (nutritional) point of view, an ecosystem has autotrophic (self-nourishing) and a heterotrophic (other nourishing) components:

  (a) Autotrophic component (Producers): This component is mainly constituted by the green plants, algae and all photosynthetic organisms. Chemosynthetic bacteria, photosynthetic bacteria, algae, grasses, mosses, shrubs, herbs and trees manufacture food from simple inorganic substances by fixing energy and are therefore called as producers.

  (b) Heterotrophic component (Consumers): The members of this component cannot make their own food. They consume the matter built by the producers and are therefore called as consumers. They may be herbivores, carnivores or omnivores. Herbivores are called as primary consumers whereas carnivores and omnivores are called as secondary consumers. Collectively we can call them as macro-consumers.

  (c) Decomposers: Heterotrophic organisms chiefly bacteria and fungi that breakdown the complex compounds of dead protoplasm, absorb some of the products and release simple substances usable by the producers are called as decomposers or reducers. Collectively we call them as micro consumers.

- **Processes of Ecosystems** This figure with the plants, zebra, lion, and so forth, illustrates the two main ideas about how ecosystems function: ecosystems have energy flows and ecosystems cycle materials. These two processes are linked, but they are not quite the same.



Energy flows and material cycles.

- ✓ Energy enters the biological system as light energy, or photons, is transformed into chemical energy in organic molecules by cellular processes including photosynthesis and respiration, and ultimately is converted to heat energy.
- ✓ This energy is dissipated, meaning it is lost to the system as heat; once it is lost it cannot be recycled. Without the continued input of solar energy, biological systems would quickly shut down. Thus the Earth is an open system with respect to energy.
- ✓ Elements such as carbon, nitrogen, or phosphorus enter living organisms in a variety of ways. Plants obtain elements from the surrounding atmosphere, water, or soils. Animals may also obtain elements directly from the physical environment, but usually they obtain these mainly as a consequence of consuming other organisms.
- ✓ These materials are transformed biochemically within the bodies of organisms, but sooner or later, due to excretion or decomposition, they are returned to an inorganic state (that is, inorganic material such as carbon, nitrogen, and phosphorus, instead of those elements being bound up in organic matter). Often bacteria complete this process, through the process called decomposition or mineralization.
- ✓ During decomposition these materials are not destroyed or lost, so the Earth is a closed system with respect to elements. The elements are cycled endlessly between their biotic and abiotic states within ecosystems. Those elements whose supply tends to limit biological activity are called nutrients.

- **<u>Functions of Ecosystem-</u>**

The functions of the ecosystem are as follows:

- ✓ It regulates the essential ecological processes, supports life systems and renders stability.
- ✓ It is also responsible for the cycling of nutrients between biotic and abiotic components.
- ✓ It maintains a balance among the various trophic levels in the ecosystem.
- ✓ It cycles the minerals through the biosphere.
- ✓ The abiotic components help in the synthesis of organic components that involves the exchange of energy.

- **Why Is Preserving Ecosystems Important?**

- ✓ Like all other living beings, humans are dependent on natural ecosystem services to survive. We need it to get the food we eat, the water we drink and to transform raw materials into our everyday products. So in order to keep our living conditions, it's truly important that we preserve natural ecosystems.
- ✓ **For example**, the agriculture that provides our food depends on the characteristics of a specific ecosystem. Cereals or vegetables grow only under certain conditions of temperature and humidity. They also need certain natural processes, such as pollination, to take place.
- ✓ If we change these characteristics too intensely, there is the risk that we aren't able to produce what we produce today, or at least not in the same way. That's why there are some agricultural techniques that understand and manage food production (such as agro forestry, permaculture or regenerative agriculture) that the wider impacts of using herbicides, pesticides, exhausting nearby water sources or betting on different types of trees that make ecosystems more resilient.

- **Food Chain: Introduction**

- ✓ A food chain explains which organism eats another organism in the environment. The food chain is a linear sequence of organisms where nutrients and energy is transferred from one organism to the other.
- ✓ This occurs when one organism consumes another organism. It begins with producer organism, follows the chain and ends with decomposer organism. After understanding the food chain, we realize how one organism is dependent upon another species for survival. All food chains may not process if there is absence of bacteria on the earth.
- ✓ **What is a food chain**?
- ✓ A food chain refers to the order of events in an ecosystem, where one living organism eats another organism, and later that organism is consumed by another larger organism. The flow of nutrients and energy from one organism to another at different trophic levels forms a food chain.
- ✓ The food chain also explains the feeding pattern or relationship between living organisms. Trophic level refers to the sequential stages in a food chain, starting with producers at the bottom, followed by primary, secondary and tertiary consumers. Every level in a food chain is known as a trophic level.

- The food chain consists of **four major parts**, namely:

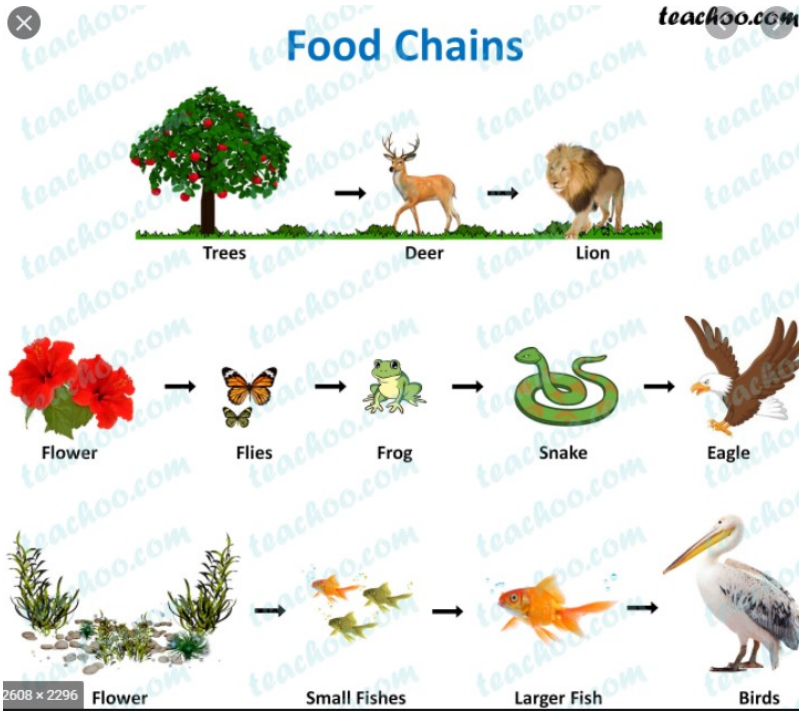
1) **The Sun**: The sun is the initial source of energy, which provides energy for everything on the planet.
2) **Producers**: The producers in a food chain include all green plants. This is the first stage in a food chain. The producers make up the first level of a food chain. The producers utilize the energy from the sun to make food. Producers are also known as autotrophs as they make their own food. Producers are any plant or other organisms that produce their own nutrients through photosynthesis. For example, green plants, fruits, phytoplanktons, small plants, and algae are some examples of producers in a food chain.
3) **Consumers:** Consumers are all organisms that are dependent on plants or other organisms for food. This is the largest part of a food web, as it contains almost all living organisms. It includes herbivores which are animals that eat plants, carnivores which are animals that eat other animals, parasites are those organisms that live on other organisms by harming them and lastly the scavengers, which are animals that eat dead animals' carcasses.

   Here, herbivores are known as primary consumers and carnivores are secondary consumers. The second trophic level includes organisms that eat producers. Therefore, primary consumers or herbivores are organisms in the second trophic level.

4) **Decomposers**: Decomposers are organisms that get energy from dead or waste organic material. This is the last stage in a food chain. Decomposers are an integral part of a food chain, as they convert organic waste materials into inorganic materials like nutrient-rich soil or land.

- ✓ Decomposers complete a life cycle, as they provide nutrients to soil or oceans,that can be utilized by autotrophs or producers. Thus, starting a whole new food chain.
- ✓ All processes in this world, whether living or non-living, need energy. Living organisms are capable of producing energy or getting it through predation. They need this energy to maintain cells and tissues.
- ✓ It is also required for supporting voluntary and involuntary actions of the human body and other multiple processes within the body like reproduction, cell division, metabolism, digestion, circulation, excretion, and much more.

✓ The ultimate source of energy on Earth is the Sun. No energy can be produced without the sun. All living beings, especially plants capture solar energy and utilise it for their food production. This process is called photosynthesis.



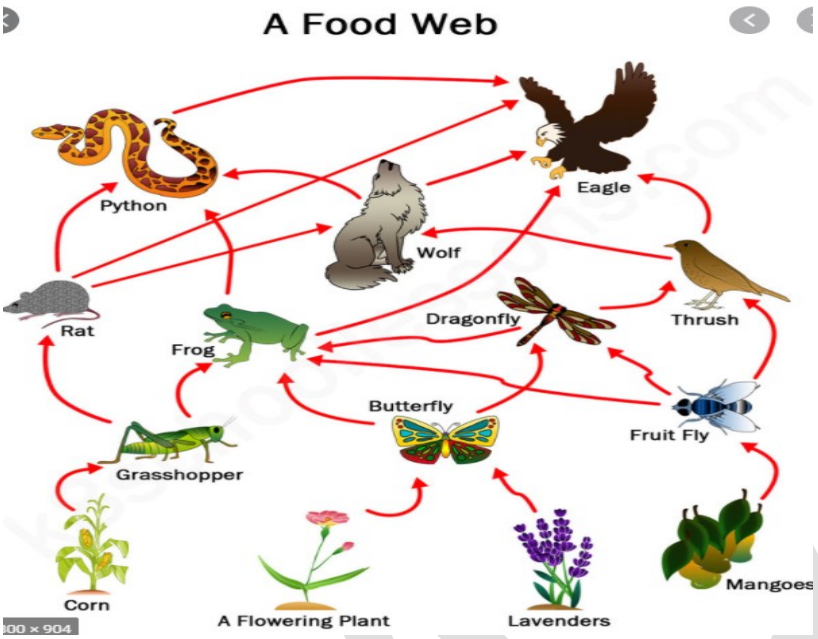
- **What is Food Web?**

✓ There are unique interactions and relationships which are involved in the transportation of energy. The energy, once produced and captured, is distributed throughout the various living organisms. This transfer of energy is termed as the **food web**.

- **What is the difference between the food chain and food web?**

✓ A food chain follows a single path, where animals discover food. But a food web shows different paths, where plants and animals are connected. A food web comprises several food chains.
✓ In a food chain, an organism eats a single item, whereas in a food web an organism consumes multiple items. In a food chain, there is a singular path for energy flow and in a food web, there are different paths for energy flow.
✓ Many interconnected food chains make up a food web. When you look at the larger picture, a food web shows a realistic representation of the energy flow through different organisms in an ecosystem.
✓ Sometimes, a single organism gets eaten by many predators or it eats many other organisms. This is when a food chain doesn't represent the energy flow in a proper manner because there are many trophic levels that interconnect. This is where a food web comes into place. It shows the interactions between different organisms in an ecosystem.

The following diagram shows the energy flow between various organisms through a food web.



- **What is Ecological Pyramid?**

✓ An ecological pyramid is a graphical representation of the relationship between the different living organisms at different trophic levels.

✓ It can be observed that these pyramids are in the shape of actual pyramids with the base being the broadest, which is covered by the lowest trophic level, i.e., producers. The next level is occupied by the next trophic level, i.e., the primary consumers and so on.

✓ All the calculations for construction of these types of ecological pyramids must take into account all the organisms in a particular trophic level because a sample space of a few numbers or a few species will end up giving a huge level of errors.

- **<u>Types of Ecological Pyramids</u>**

✓ **Pyramid of numbers-** This shows the number of organisms in each trophic level without any consideration for their size. This type of pyramid can be convenient, as counting is often a simple task and can be done over the years to observe the changes in a particular ecosystem. However, some types of organisms are difficult to count, especially when it comes to some juvenile forms.

✓ **Pyramid of biomass-** This indicates the total mass of organisms at each trophic level. Usually, this type of pyramid is largest at the bottom and gets smaller going up, but exceptions do exist.

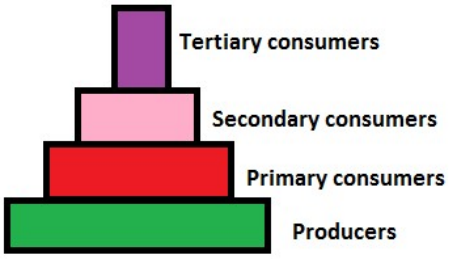
✓ The biomass of one trophic level is calculated by multiplying the number of individuals in the trophic level by the average mass of one individual in a particular area. This type of ecological pyramid solves

some problems of the pyramid of numbers, as it shows a more accurate representation of the amount of energy contained in each trophic level, but it has its own limitations.

- ✓ For example, the time of year when the data are gathered is very important, since different species have different breeding seasons. Also, since it's usually impossible to measure the mass of every single organism, only a sample is taken, possibly leading to inaccuracies.
- ✓ **Pyramid of productivity -** The pyramid of productivity looks at the total amount of energy present at each trophic level, as well as the loss of energy between trophic levels. Since this type of representation takes into account the fact that the majority of the energy present at one trophic level will not be available for the next one, it is more accurate than the other two pyramids.
- ✓ This idea is based on Lindeman's Ten Percent Law, which states that only about 10% of the energy in a trophic level will go towards creating biomass. In other words, only about 10% of the energy will go into making tissue, such as stems, leaves, muscles, etc. in the next trophic level. The rest is used in respiration, hunting, and other activities, or is lost to the surroundings as heat. What's interesting, however, is that toxins are passed up the pyramid very efficiently, which means that as we go up the ecological pyramid, the amount of harmful chemicals is more and more concentrated in the organisms' bodies. This is what we call *biomagnification*.

- **Types of Ecological Pyramid-** Three types of ecological pyramid exist. They are as follows:

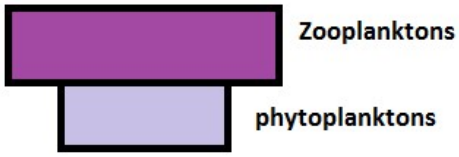
1) **Pyramid of Numbers**



Pyramid of numbers

In this type of ecological pyramid, the number of organisms in each trophic level is considered as a level in the pyramid. The pyramid of numbers is usually upright except for some situations like that of the detritus food chain, where many organisms feed on one dead plant or animal.

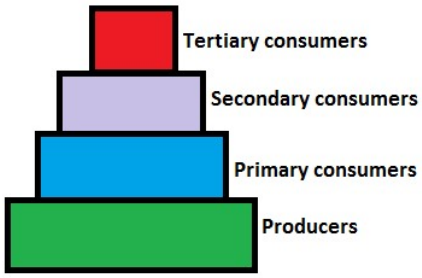
2) Pyramid of Biomass



Pyramid of biomass in oceans

In this particular type of ecological pyramid, each level takes into account the amount of biomass produced by each trophic level. The pyramid of biomass is also upright except for that observed in oceans where large numbers of zooplanktons depend on a relatively smaller number of phytoplanktons.

3) Pyramid of Energy



Pyramid of energy

Pyramid of energy is the only type of ecological pyramid, which is always upright as the energy flow in a food chain is always unidirectional. Also, with every increasing trophic level, some energy is lost into the environment.

- **Importance of Ecological Pyramid :** The importance of ecological pyramid can be explained in the following points:

1. They show the feeding of different organisms in different ecosystems.
2. It shows the efficiency of energy transfer.
3. The condition of the ecosystem can be monitored, and any further damage can be prevented.

- **Limitations of the Ecological Pyramid**

1. More than one species may occupy multiple trophic levels as in case of the food web. Thus, this system does not take into account food webs.
2. The saprophytes are not considered in any of the pyramids even though they form an important part of the various ecosystem.
3. These pyramids are applicable only to simple food chains, which usually do not occur naturally.
4. These pyramids do not deliver any concept in relation to variations in season and climate.

5. They do not consider the possibility of the existence of the same species at different levels.

- **Industrial Ecology-**

- ✓ Industrial ecology (IE) is the study of material and energy flows through industrial systems. The global industrial economy can be modelled as a network of industrial processes that extract resources from the Earth and transform those resources into commodities which can be bought and sold to meet the needs of humanity.
- ✓ Industrial ecology seeks to quantify the material flows and document the industrial processes that make modern society function. Industrial ecologists are often concerned with the impacts that industrial activities have on the environment, with use of the planet's supply of natural resources, and with problems of waste disposal.
- ✓ Industrial ecology is a young but growing multidisciplinary field of research which combines aspects of engineering, economics, sociology, toxicology and the natural sciences.
- ✓ Industrial ecology has been defined as a "systems-based, multidisciplinary discourse that seeks to understand emergent behaviour of complex integrated human/natural systems". The field approaches issues of sustainability by examining problems from multiple perspectives, usually involving aspects of sociology, the environment, economy and technology.
- ✓ The name comes from the idea that the analogy of natural systems should be used as an aid in understanding how to design sustainable industrial systems.
- ✓ Industrial ecology conceptualises industry as a man-made ecosystem that operates in a similar way to natural ecosystems, where the waste or by product of one process is used as an input into another process. Industrial ecology interacts with natural ecosystems and attempts to move from a linear to cyclical or closed loop system. Like natural ecosystems, industrial ecology is in a continual state of flux.

- **Main Features**

- ✓ Industrial processes, from material extraction through to product disposal, have an adverse impact upon the environment. Industrial ecology aims to reduce environmental stress caused by industry whilst encouraging innovation, resource efficiency and sustained growth.
- ✓ Industrial ecology acknowledges that industry will continue operate and expand however, it supports industry that is environmentally conscious and has less burden upon the planet. It views industrial sites as part of a wider ecology rather than an external, solitary entity.
- ✓ Within the industrial ecology concept, industry interacts with nature and utilises the wastes and by products of other industries as inputs into its own processes.
- ✓ Industrial ecology ranges from purely industrial ecosystems to purely natural ecosystems with a range of hybrid industrial/natural ecosystems in between. Covering both industrial management and technology, industrial ecology encompasses other sustainability concepts and tools such as material flows analysis; environmentally sound technologies; design for disassembly; and dematerialisation.
- ✓ Industrial ecology aims to reduce the environmental impact of industry by examining material and energy flows in products, processes, industrial sectors, and economies.
- ✓ Industrial ecology provides a long-term perspective, encouraging consideration of the overall development of both technologies and policies for sustainable resource utilization and environmental protection into the future.
- ✓ It emphasizes opportunities for new technologies and new processes, and those for economically beneficial efficiencies. Industrial ecology draws on and extends a variety of related approaches

including systems analysis, industrial metabolism , materials flow analysis, life cycle analysis, pollution prevention, design for environment, product stewardship , energy technology assessment, and eco-industrial parks.

- ✓ Greater material efficiency, the use of better materials, and the growth of the service economy can contribute to the "dematerialization" of the economy. Resources that are cheap, abundant, and environmentally benign may be used to replace those that are expensive, scarce, or environmentally harmful.
- ✓ Such a substitution can be seen in the many important changes in energy sources that have occurred over the past century. As the energy sources have shifted from wood and coal toward petroleum and natural gas, the average amount of carbon per unit energy produced has decreased significantly, resulting in the "decarbonization" of world energy use.
- ✓ Another industrial ecology strategy is to use waste products as raw materials. These efforts often come into conflict with concerns about hazardous materials in the wastes, such as the concern that trace metals in ash from power plants recycled in fertilizer may contaminate soil.
- ✓ However, in some cases, such waste reuse can be successful. In the industrial district in Kalundborg, Denmark, several industries, including the town's power station, oil refinery, and plasterboard manufacturer, make use of waste streams and energy resources, and turn by-products into products.
- ✓ There are many examples of technological innovations that have had significant environmental benefits. An important example is the replacement of chlorofluorocarbons (CFCs) with new compounds in order to protect the stratospheric ozone layer. Other examples are the elimination of mercury in batteries, and the elimination of lead in gasoline, paint, and solder.
- ✓ The challenge of industrial ecology is to understand how technological and social innovation can be harnessed to solve environmental problems and provide for the well-being of the entire world.

- What if the waste of one business could be a resource for another? Known as ‘industrial ecology’ or ‘industrial symbiosis’, networks are being set up to facilitate the exchange of one company’s waste so it becomes the input for another’s business.

➢ **Resource go-round-** Industrial ecology is where one company’s trash becomes another’s treasure. It focuses on the sustainable combination of business, environment, and technology, while the subset, industrial symbiosis, focuses on material and energy exchange. It’s a circular economy based system in which waste is reused in new processes and is a closed loop process, whereas in liner systems waste would just be disposed of.

- **The Benefits to business:** As the cost of waste disposal increases it becomes less cost-effective to send material to landfill. To be seen as efficient and socially responsible, businesses need to consider the end-of-pipe impacts of their activities. In addition to reducing the demands on the earth’s resources, industrial ecology has benefits to business. This includes:

  - Reduced operating costs
  - New business opportunities and jobs
  - Improved technical processes
  - Improved awareness of waste streams

- **Recycling-** Recycling is the process of converting waste materials into new materials and objects. The recovery of energy from waste materials is often included in this concept.

✓ The recyclability of a material depends on its ability to reacquire the properties it had in its original state. It is an alternative to "conventional" waste disposal that can save material and help lower greenhouse gas emissions.

✓ Recycling can prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, thereby reducing: energy usage, air pollution and water pollution (from land filling).

- Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy. Thus, recycling aims at environmental sustainability by substituting raw material inputs into and redirecting waste outputs out of the economic system.
- There are some ISO standards related to recycling such as ISO 15270:2008 for plastics waste and ISO 14001:2015 for environmental management control of recycling practice.
- Recyclable materials include many kinds of glass, paper, cardboard, metal, plastic, tires, textiles, batteries, and electronics. The composting or other reuse of biodegradable waste—such as food or garden waste—is also a form of recycling.
- Materials to be recycled are either delivered to a household recycling center or picked up from curbside bins, then sorted, cleaned, and reprocessed into new materials destined for manufacturing new products.

➢ In simple words, **Recycling** is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. Recycling can benefit your community and the environment.

- **Benefits of Recycling**

1. **Conserving natural resources**-The world's natural resources are finite, and some are in very short supply.

At a fundamental level:

✓ Recycling paper and wood saves trees and forests. Yes, you can plant new trees, but you can't replace original rainforest or ancient woodlands once they're lost.

✓ Recycling plastic means creating less new plastic, which is definitely a good thing, especially as it's usually made from fossil fuel hydrocarbons.

✓ Recycling metals means there's less need for risky, expensive and damaging mining and extraction of new metal ores.

✓ Recycling glass reduces the need to use new raw materials like sand – it sounds hard to believe, but supplies of some types of sand are starting to get low around the world.

2. Protecting ecosystems and wildlife

✓ Recycling reduces the need to grow, harvest or extract new raw materials from the Earth.

✓ That in turn lessens the harmful disruption and damage being done to the natural world: fewer forests cut down, rivers diverted, wild animals harmed or displaced, and less pollution of water, soil and air.

- ✓ And of course if our plastic waste isn't safely put in the recycling, it can be blown or washed into rivers and seas and end up hundreds or thousands of miles away, polluting coastlines and waterways and becoming a problem for everyone.

3. Reducing demand for raw materials

- ✓ As with point 2 above – the world's increasing demand for new stuff has led to more of the poorest and most vulnerable people (for example, those living around forests or river systems) being displaced from their homes, or otherwise exploited.
- ✓ Forest communities can find themselves evicted as a result of the search for cheap timber and rivers can be damned or polluted by manufacturing waste.
- ✓ It's far better to recycle existing products than to damage someone else's community or land in the search for new raw materials.

4. Saving energy

- ✓ Making products from recycled materials requires less energy than making them from new raw materials. Sometimes it's a huge difference in energy. For example: Producing new aluminium from old products (including recycled cans and foil) uses 95% less energy than making it from scratch. For steel it's about a 70% energy saving.
- ✓ Making paper from pulped recycled paper uses 40% less energy than making it from original wood fibres.
- ✓ The amount of energy saved from recycling one glass bottle could power an old 100-watt light bulb for 4 hours and a new low-energy LED equivalent for a lot longer.

5. Cutting climate-changing carbon emissions

- ✓ Because recycling means you need to use less energy on sourcing and processing new raw materials, it produces lower carbon emissions. It also keeps potentially methane-releasing waste out of landfill sites.
- ✓ Reducing carbon dioxide and other greenhouse gases being emitted into the atmosphere is vital for stopping disastrous climate change.

6. Cheaper than waste collection and disposal

- ✓ Lambeth council in London pointed out in 2017 that "it is 6 times cheaper to dispose of recycled waste than general refuse." So, the more you recycle, and the less you put in the bin, the more money is saved, which should be good for households, businesses and local public services.
- ✓ Recycling food waste and green waste is a great idea too, often generating lots of valuable compost that can be used to grow more food and other crops.
- ✓ A new deposit return scheme being introduced for cans or bottles could offer an added financial incentive to recycle – because you'll lose your deposit if you don't.

7. Reduces the amount of waste sent to landfills and incinerators

8. Conserves natural resources such as timber, water and minerals

9. Increases economic security by tapping a domestic source of materials

10. Prevents pollution by reducing the need to collect new raw materials

11. Saves energy

12. Supports American manufacturing and conserves valuable resources

13. Helps create jobs in the recycling and manufacturing industries.

- **<u>Steps to Recycling Materials</u>-** Recycling includes the three steps below, which create a continuous loop, represented by the familiar recycling symbol.

Step 1: Collection and Processing

- ✓ There are several methods for collecting recyclables, including curbside collection, drop-off centers, and deposit or refund programs.
- ✓ After collection, recyclables are sent to a recovery facility to be sorted, cleaned and processed into materials that can be used in manufacturing. Recyclables are bought and sold just like raw materials would be, and prices go up and down depending on supply and demand in the United States and the world.

Step 2: Manufacturing

- ✓ More and more of today's products are being manufactured with recycled content. Common household items that contain recycled materials include the following:
  - Newspapers and paper towels
  - Aluminum, plastic, and glass soft drink containers
  - Steel cans
  - Plastic laundry detergent bottles
- ✓ Recycled materials are also used in new ways such as recovered glass in asphalt to pave roads or recovered plastic in carpeting and park benches.

Step 3: Purchasing New Products Made from Recycled Materials

- ✓ You help close the recycling loop by buying new products made from recycled materials. There are thousands of products that contain recycled content. When you go shopping, look for the following:
  - Products that can be easily recycled
  - Products that contain recycled content
- ✓ Below are some of the terms used:

- **Recycled-content product** - The product was manufactured with recycled materials either collected from a recycling program or from waste recovered during the normal manufacturing process. The label will sometimes include how much of the content was from recycled materials.
- **Post-consumer content** - Very similar to recycled content, but the material comes only from recyclables collected from consumers or businesses through a recycling program.
- **Recyclable product** - Products that can be collected, processed and manufactured into new products after they have been used. These products do not necessarily contain recycled materials. Remember not all kinds of recyclables may be collected in your community so be sure to check with your local recycling program before you buy.

- Some of the common products you can find that can be made with recycled content include the following:
  - Aluminum cans
  - Car bumpers
  - Carpeting
  - Cereal boxes
  - Comic books
  - Egg cartons
  - Glass containers
  - Laundry detergent bottles
  - Motor oil
  - Nails
  - Newspapers
  - Paper towels
  - Steel products
  - Trash bags

- **Secondary Recycling-**

✓ There are **three** main types of recycling: primary, secondary, and tertiary. Primary recycling, also known as closed loop recycling, is the process of turning one thing into more of the same thing, like paper into more paper or soda cans into more soda cans.

✓ Secondary recycling means turning something into other things made of the same material in essentially the same form.

✓ Tertiary or chemical recycling, on the other hand, requires breaking materials down chemically to produce something very different.

✓ The Classic Example: Tire Recycle

✓ Tire recycling is a classic example of a secondary recycling process. It isn't primary recycling, because the vast majority of recycled tires do not end up as new tires. Instead, they're turned into other products made with rubber. And since there is no chemical change required like in tertiary recycling, the right machinery can turn a used tire directly into usable materials.

- **Why It's Important**

- Reduces Waste
- ✓ Recycling naturally reduces waste by keeping more things out of landfills, but secondary recycling is especially important because it means more and more items can be recycled into more and more different end-products.
- ✓ When recycling isn't limited to things like aluminum cans that can be reproduced into themselves, the possibilities for recycling expand significantly. It also helps us get the most from materials that aren't infinitely recyclable, making them go as far as possible before they reach the end of their recycling lifespan.

- Fuels Innovation
- ✓ While primary recycling lets you create more of the same product without using more natural resources, secondary recycling creates opportunities for finding new ways to incorporate materials from used products into things we already produce and into new things we may not have thought of before.

- Saves Resource
- ✓ Of course, secondary recycling saves natural resources, too. When recycling provides "new" sources of useful materials, there are fewer finite resources being used up in production. For example, shredding used tires for rubber provides a source for valuable rubber products without having to harvest more natural rubber or use resources to produce synthetic varieties.

- Is Efficient

  Secondary recycling can also be very efficient. It can take less time and equipment than processes that require you to chemically break down materials. The quicker you can turn an un-usable product into a usable one, the better. Conservation is the purpose of recycling after all, so saving energy makes recycling all the more worth it.

- **Why We Need More???**
- ✓ Of course developers, entrepreneurs, and engineers should be working to find new recyclables and new ways to use them. But there also need to be more businesses engaged in the recycling processes that are available right now.
- ✓ With excellent technologies on the market, there are plenty of ways for recycling operations to expand their secondary recycling operations. The more secondary recycling processes we can develop and use, the better for consumers, for recycling businesses, and, of course, for the world.

- **What is EMS??**
- ✓ An environmental management system (EMS) is "a system and database which integrates procedures and processes for training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders of a firm"

- ✓ The most widely used standard on which an EMS is based is International Organization for Standardization (ISO) 14001.
- ✓ An Environmental Management System (EMS) is a framework that helps an organization achieve its environmental goals through consistent review, evaluation, and improvement of its environmental performance.
- ✓ The assumption is that this consistent review and evaluation will identify opportunities for improving and implementing the environmental performance of the organization. The EMS itself does not dictate a level of environmental performance that must be achieved; each organization's EMS is tailored to the its own individual objectives and targets.

- **Elements of EMS**

- ✓ An EMS helps an organization address its regulatory demands in a systematic and cost-effective manner. This proactive approach can help reduce the risk of non-compliance and improve health and safety practices for employees and the public.
- ✓ An EMS can also help address non-regulated issues, such as energy conservation, and can promote stronger operational control and employee stewardship. Basic Elements of an EMS include the following:
    - Reviewing the organization's environmental goals;
    - Analyzing its environmental impacts and legal requirements;
    - Setting environmental objectives and targets to reduce environmental impacts and comply with legal requirements;
    - Establishing programs to meet these objectives and targets;
    - Monitoring and measuring progress in achieving the objectives;
    - Ensuring employees' environmental awareness and competence; and,
    - Reviewing progress of the EMS and making improvements.

- **Costs and Benefits of an EMS**

- ✓ Internal
- ✓ Staff/manager time (represents the bulk of EMS resources expended by most organizations)
- ✓ Other employee time
- ✓ External
- ✓ Potential consulting assistance
- ✓ Outside training of personnel
- ✓ Potential Benefits
- ✓ Improved environmental performance
- ✓ Enhanced compliance
- ✓ Pollution prevention
- ✓ Resource conservation
- ✓ New customers/markets
- ✓ Increased efficiency/reduced costs

- ✓ Enhanced employee morale
- ✓ Enhanced image with public, regulators, lenders, investors
- ✓ Employee awareness of environmental issues and responsibilities

- **Features:**

An environmental management system (EMS):

- ✓ Serves as a tool, or process, to improve environmental performance and information mainly "design, pollution control and waste minimization, training, reporting to top management, and the setting of goals"
- ✓ Provides a systematic way of managing an organization's environmental affairs
- ✓ Is the aspect of the organization's overall management structure that addresses immediate and long-term impacts of its products, services and processes on the environment.
- ✓ EMS assists with planning, controlling and monitoring policies in an organization.
- ✓ Gives order and consistency for organizations to address environmental concerns through the allocation of resources, assignment of responsibility and ongoing evaluation of practices, procedures and processes.
- ✓ Creates environmental buy-in from management and employees and assigns accountability and responsibility.
- ✓ Sets framework for training to achieve objectives and desired performance.
- ✓ Helps understand legislative requirements to better determine a product or service's impact, significance, priorities and objectives.
- ✓ Focuses on continual improvement of the system and a way to implement policies and objectives to meet a desired result. This also helps with reviewing and auditing the EMS to find future opportunities.
- ✓ Encourages contractors and suppliers to establish their own EMS.
- ✓ Facilitates e-reporting to federal, state and provincial government environmental agencies through direct upload.

- **What is ISO 14000?**

- ✓ ISO 14000 is a set of rules and standards created to help companies reduce industrial waste and environmental damage.
- ✓ It's a framework for better environmental impact management, but it's not required. Companies can get ISO 14000 certified, but it's an optional certification.
- ✓ The ISO 14000 series of standards was introduced in 1996 by the International Organization for Standardization (ISO) and most recently revised in 2015 (ISO is not an acronym; it derives from the ancient Greek word ísos, meaning equal or equivalent.)
- ✓ ISO 14000 is part of a series of standards that address certain aspects of environmental regulations. It's meant to be a step-by-step format for setting and then achieving environmentally-friendly objectives for business practices or products. The purpose is to help companies manage processes while minimizing environmental effects.

- ✓ The most notable standard is ISO 14001, which lays out the guidelines for putting an environmental management system (EMS) in place. Then there's ISO 14004, which offers additional insight and specialized standards for implementing an EMS.
- ✓ Here are the key standards included in ISO 14000:

ISO 14001: Specification of Environmental Management Systems

ISO 14004: Guideline Standard

ISO 14010 – ISO 14015: Environmental Auditing and Related Activities

ISO 14020 – ISO 14024: Environmental Labeling

ISO 14031 and ISO 14032: Environmental Performance Evaluation

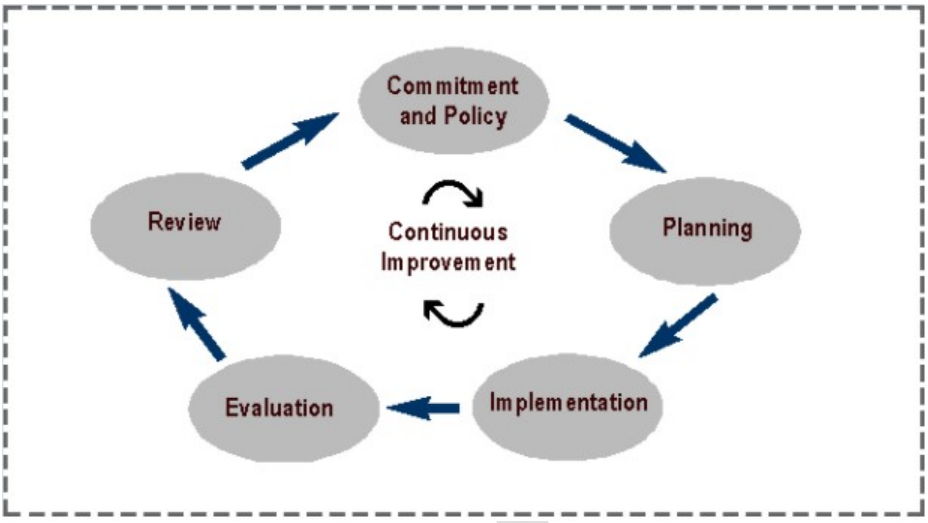
ISO 14040 – ISO 14043: Life Cycle Assessment

ISO 14050: Terms and Definitions

- **Compliance to an ISO 14000 EMS:**

- ✓ Assures customers of your commitment to demonstrable environmental management
- ✓ Maintains excellent public relations
- ✓ Satisfies investor criteria and improves access to capital
- ✓ Obtains insurance at reasonable cost
- ✓ Enhances your image and market share
- ✓ Meets your clients' registration requirements
- ✓ Improves cost control by identifying and eliminating waste and inefficiency
- ✓ Lessens incidents that result in liability
- ✓ Reduces your consumption of materials and energy
- ✓ Facilitates the attainment of permits and authorizations
- ✓ Decreases the cost of complying with environmental regulations
- ✓ Improves industry-government relations

- An EMS encourages an organization to continuously improve its environmental performance. The system follows a repeating cycle. The organization first commits to an environmental policy, then uses its policy as a basis for establishing a plan, which sets objectives and targets for improving environmental performance.
- The next step is implementation. After that, the organization evaluates its environmental performance to see whether the objectives and targets are being met. If targets are not being met, corrective action is taken. The results of this evaluation are then reviewed by top management to see if the EMS is working.
- Management revisits the environmental policy and sets new targets in a revised plan. The company then implements the revised plan. The cycle repeats, and continuous improvement occurs.



1. **Commitment and Policy** - Top management commits to environmental improvement and establishes the organization's environmental policy. The policy is the foundation of the EMS.

2. **Planning** - An organization first identifies environmental aspects of its operations. Environmental aspects are those items, such as air pollutants or hazardous waste that can have negative impacts on people and/or the environment.

- ✓ An organization then determines which aspects are significant by choosing criteria considered most important by the organization. For example, an organization may choose worker health and safety, environmental compliance, and cost as its criteria.
- ✓ Once significant environmental aspects are determined, an organization sets objectives and targets. An objective is an overall environmental goal (e.g., minimize use of chemical X). A target is a detailed, quantified requirement that arises from the objectives (e.g., reduce use of chemical X by 25% by September 1998).
- ✓ The final part of the planning stage is devising an action plan for meeting the targets. This includes designating responsibilities, establishing a schedule, and outlining clearly defined steps to meet the targets.

3. **Implementation** - An organization follows through with the action plan using the necessary resources (human, financial, etc.). An important component is employee training and awareness for all employees. Other steps in the implementation stage include documentation, following operating procedures, and setting up internal and external communication lines.

4. **Evaluation** - A company monitors its operations to evaluate whether targets are being met. If not, the company takes corrective action.

5. **Review** - Top management reviews the results of the evaluation to see if the EMS is working. Management determines whether the original environmental policy is consistent with the organization's

values. The plan is then revised to optimize the effectiveness of the EMS. The review stage creates a loop of continuous improvement for a company.

- **Principles of environmental management**

Standards outlined in the ISO 14000 family are designed with key principles of environmental management in mind:

- ✓ To encompass environmental management systems and the environmental aspects of products
- ✓ To not be restricted by country or region
- ✓ To uphold and promote public interest as well as the interests of those who use and be affected by the standards
- ✓ To be cost-efficient, robust, and adapt to many different needs, requirements, and circumstances, at any scale, globally
- ✓ As part of their flexibility, to be suitable for internal and/or external verification
- ✓ To utilize scientific evidence and principles
- ✓ To continuously improve upon existing principles of environmental management
- ✓ To be actionable, practical, and useful for organizations using them

- **Why ISO 14000 is important?**

- ✓ In today's global economy, ISO 14000 is crucial for tackling economic, environmental and social aspects, or the so-called "triple-bottom line" of how they function.
- ✓ Utilizing ISO 14000 can help to gain advantages in finance, insurance, marketing, regulation, and a wide range of interdisciplinary areas.
- ✓ The standards help organizations prepare with a proactive approach, as opposed to a reactive one, and totally assess their environmental impact, even addressing certain factors that may be unregulated, such as energy or resource allocation.
- ✓ Below are some more reasons ISO 14000 is important:
- ✓ **Risk reduction**- By assessing and becoming aware of factors such as rising energy costs and uncertainty in supply, companies can take preventative measures and mitigate risk.
- ✓ **Leading by example**- Companies will traditionally adopt sustainability strategies for compliance with government regulation and to avoid being fined. However, at this point, adoption of sustainable environmental policies are considered part of a cutting-edge movement of awareness of environmental policy.
- ✓ **Tax incentives**- Many federal, state, and local government bodies in the USA offer a wide breadth of tax incentives for companies that choose to adopt and implement environmentally responsible standard operating procedures. These incentives can take the form of investment-based, production-based, or consumption-based tax credits, improved capital expenses, cash grants, and certain tax exemptions.
- ✓ **For your employees-** Many employees are excited and invigorated by the potential of devoting their workplace efforts towards bigger causes. When environmental policies are a part of corporate culture, it can go a long way to attract and retain workers.

- ✓ **Brand image and PR**- Fostering environmental policies such as those outlined in the ISO 14000 can go a long way to improve customer relations and ultimately build a long-lasting and positive brand image.
- ✓ **Renewable & non-renewable resources-** Natural resources such as fossil fuels are finite; even renewable resources must be managed adequately with standards designed to support sustainability. As resources become more scarce, cost will also rise. Companies will inevitably have to prepare for this eventuality by adopting sustainability plans or planning for alternatives.
- ✓ **Competition-** This MIT survey from 2011 of almost 3,000 executives found that about two-thirds of those surveyed believe sustainability to be necessary in order to viably compete in today's market.

- Why should your company care about the environment?
- ✓ In short, because it's what your customer wants, and it could actually save you money.
- ✓ Studies have shown that a lot of consumers actually care about the planet and environment; recent studies especially reflect this.
- ✓ A Unilever study shows that: 33% of consumers prefer to buy goods and services from "socially or environmentally active" brands.
- ✓ 21% of consumers prefer brands that use sustainable packaging.
- ✓ Basically, consumers want to know that their favorite brands are doing something to support the environment. Consumers, being aware of problems like global waste and (non)renewable-resources, want to know what these companies are doing to support environmental sustainability, as well as wider ecological issues like land preservation, animal handling, water quality control, and waste disposal.
- ✓ Consumers want more than just quality and affordability. In the current information age, companies' environmental and social responsibilities are closely and effortlessly surveyed by their stakeholders.
- ✓ In order to adapt to the high-visibility, high-accountability nature of social and environmental responsibility, companies will need to clearly define, implement, and communicate principles of environmental management and sustainability, in-line with the expectations of consumers and stakeholders.
- ✓ More than just an eco-friendly gesture, implementing principles of environmental management may actually make long-term economic sense for your business.
- ✓ Businesses can use principles of environmental management to discover new ways to slash costs associated with excess use of electricity, gas, and other resources. **For example**, Reyna found that simple changes like replacing light bulbs and upgrading old inefficient machinery was able to save over $1 billion in net operational costs over the course of project lifetimes.
- ✓ Being green also generates new revenue opportunities by attracting customers based on the principles of sustainability and environmental responsibility.